An ARPES-based Phase Diagram for $Bi_2Sr_2CaCu_2O_{8+\delta}$

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Introduction: The many unusual properties of high-T_c superconductors (HTS) present a challenge in unraveling the exact mechanism for superconductivity in these materials. While there is an emerging consensus on the d-wave paring symmetry for the HTS, other issues are still highly debated. Two such issues are the exact temperature scales in the phase diagram of the cuprates superconductors, and the validity of the Fermi Liquid (FL) picture in these materials. Angle-resolved photoemission spectroscopy (ARPES) was used to study $Bi_2Sr_2CaCu_2O_{8+\delta}$ (Bi2212) cuprate superconductor over a wide doping range. These data, along with results from tunneling spectroscopy, may provide a clearer picture towards resolving both issues.

Methods and Materials: Single crystals of Bi2212 were cleaved in-situ under vacuum with a base pressure of 5×10^{-11} Torr. Crystal orientation was determined using a low-energy electron diffraction (LEED) technique. All ARPES measurement were performed using a Scienta SES-200 hemispherical analyzer that simultaneously collects a large energy window (0.5 to 1 eV) and angular (12^0) window. This allows for the simultaneous collection of photoemission intensity as a function of binding energy and momentum along a particular direction of the Brillouin Zone. The resulting energy resolution is ~10 meV with an angular resolution of better than 0.2^0.

Results: New results from the highly overdoped (OD) Bi2212 indicate the possibility of a temperature scale on the OD side of the phase diagram in addition to the superconducting critical temperature T_c. This new temperature scale may signify a crossover between a “strange” metal behavior and a FL-like behavior. Combined with data from the underdoped and optimally doped Bi2212, this allows us to refine the cuprate phase diagram.

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